

DiSTeK N.A. LLC

Thermal Diffusion Galvanizing Or TDG

A Cost Effective, Environmentally Friendly
Process



Winner of EPA 2006
Most Valuable Pollution
Prevention Award (MVP²)

By: Moshe Moked, P. Eng

What is Thermal Diffusion Galvanizing?



TDG is a method of applying a uniform, *sacrificial*, Zinc Iron alloy coating using a **metallurgical vapor diffusion process**.



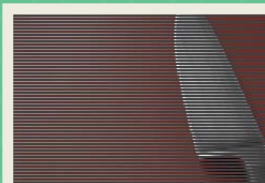
TDG Can be Applied On Many Surface Types:



Powder Metal



Steel



Stainless Steel



Castings &
Forgings

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE FEB 2009		2. REPORT TYPE		3. DATES COVERED 00-00-2009 to 00-00-2009	
4. TITLE AND SUBTITLE Thermal Diffusion Galvanizing or TDG A Cost Effective, Environmentally Friendly Process				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Distek N.A LLC,1800 Touhy Ave,Elk Grove Village,IL,60611				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES 2009 U.S. Army Corrosion Summit, 3-5 Feb, Clearwater Beach, FL					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 20	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



OVERVIEW

Superior Corrosion Protection

- Works for all steel alloys, including Stainless.
- Excellent for powder metal parts – ***no impregnation required***, fills surface voids.
- Highly Heat Resistant and Chip Proof
- Weld-able and Spark Free Surface
- Hard Abrasion Resistant Surface



Environmentally Friendly

- EPA 2006 Pollution Prevention Award (NPPR)
- Acid Free Surface Preparation
- Non Toxic Coating
- Zero Waste System



Uniform Coating of Complex Parts

- Excellent Substrate for Paint & Plastic molding
- Coats Internal Surfaces
- Coats Complex Shapes
- No Recess Fill



Hydrogen *Embrittlement* Free

- No loss of tensile strength on high carbon, hardened parts.

How is Thermal Diffusion Applied?

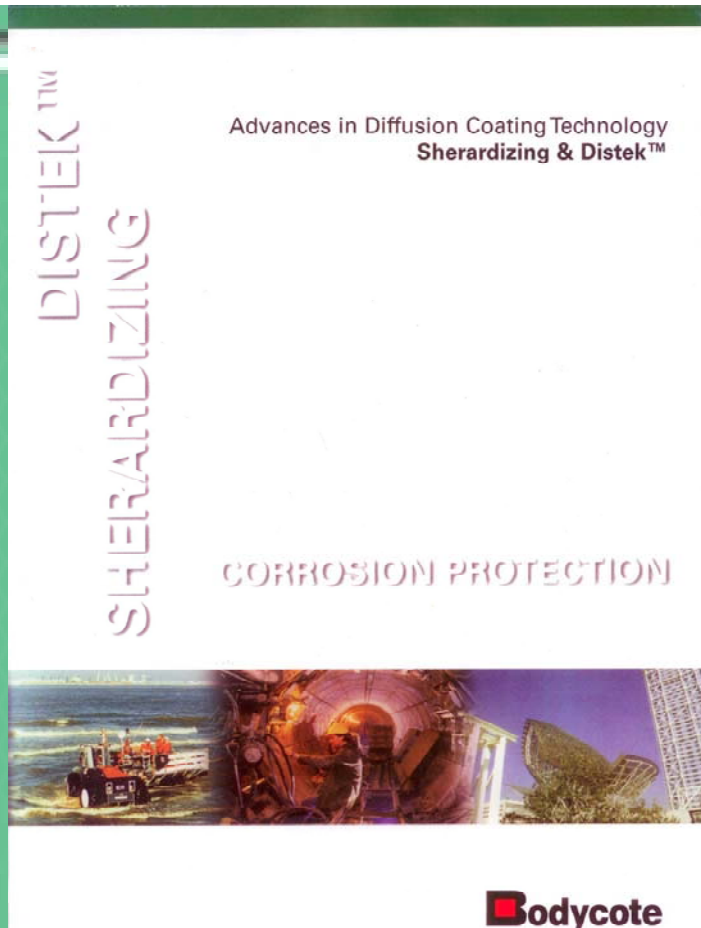
- **TDG** is applied by rotating parts in a cylinder very slowly with the **TDG** patented dry zinc mixture.
- About 750 degrees F (400 C) of heat is applied for 2-4 hours (temperatures can range from 620F to 900F).
- Parts are then cleaned, passivated and dried followed by a silicate top coat or another paint system.

Thermal Diffusion is Not a New Process

- **TDG** is also known as Sherardizing – Patented by a British metallurgist named Sherard Cowper-Coles in 1901. It has been used extensively in the UK and Europe ever since.
- For the past 25 years, the best known applicator of Sherardizing is .
- For the past five years **Bodycote** has switched to the Updated Sherardizing process.

BODYCOTE BROCHURE

Thermal
Diffusion
***Successors to
Sherardizing***



Thermal Diffusion *IN THE UNITED STATES*

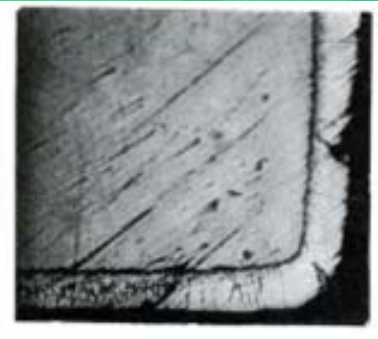
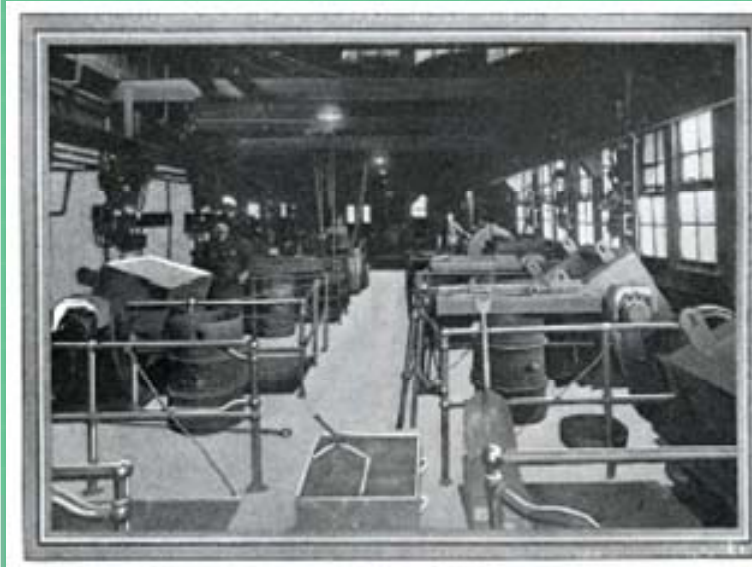
- In the first quarter of the twentieth century Sherardizing was quite popular in the US.
- There were at least 25 companies doing Sherardizing.
- Two of the most well known were General Electric and Westinghouse.
- Cyanide plating displaced it in the 1930's.

One Of The Largest Sherardizing Plants in the US in 1916



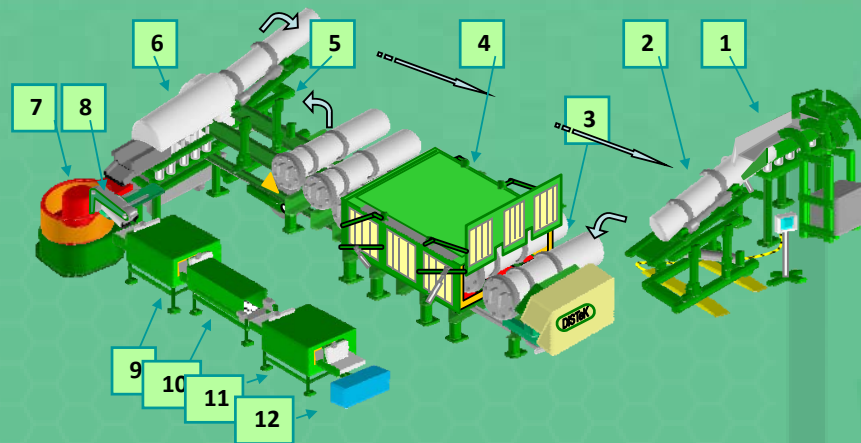
FIG. 119. VIEW OF LOADING END OF ONE OF THE LARGEST SHERARDIZING FURNACES IN THE WORLD

“Modern” Electric Sherardizing Plant at GE, 1918



1918 Micro-Photo
of a Part
Sherardized at
GE

The following is a representation of the **Thermal Diffusion** production line that will start up in the First Quarter of 2009 in Elk Grove Village, IL.



- 1-2. Process Cylinder is loaded with parts and the Thermal Diffusion powder mixture.
3. Process Cylinder is loaded on staging station.
4. Process Cylinder is loaded into the automated process oven.
5. Process Cylinders exit the oven at end of the process to cooling station.
6. Parts are emptied at this station onto vibrator to remove excess powder.
- 7-8. Parts enter vibratory finishing for polishing and passivation.
9. Drying oven. Parts are now ready for electro-coat or dip spin paint, or can move on to
10. An optional top coat applicator.
11. Drying oven.
12. Finished parts.

Characteristics of Thermal Diffusion

TDG coating is sacrificial.

TDG is Non-Galling, **acting like cadmium**.

TDG coating process **guarantees** parts free of Hydrogen Embrittlement.

TDG coating can be applied to parts made of spring or other specialty steel.

TDG coating has strong adhesion to base metal due to mutual diffusion of zinc and iron. Zinc penetrates to the base metal to about 1/3 of the coating thickness.

TDG coating is uniform, regardless of part's geometry.

TDG coating is heat resistant to 1200F

No Hydrogen Embrittlement Nor Loss of Tensile Strength



Springs

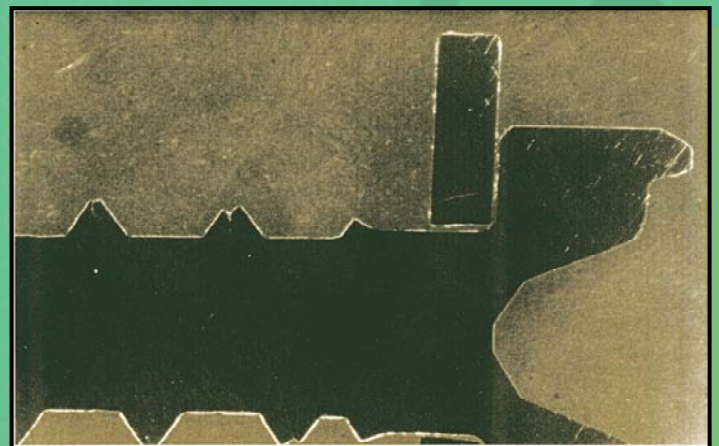


Tempered and Hardened Parts

TDG Coatings are *Extremely Uniform*

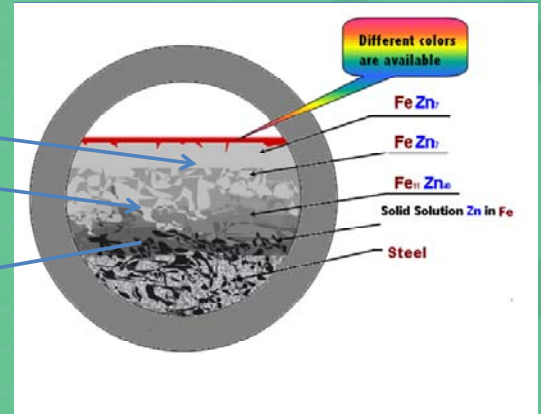
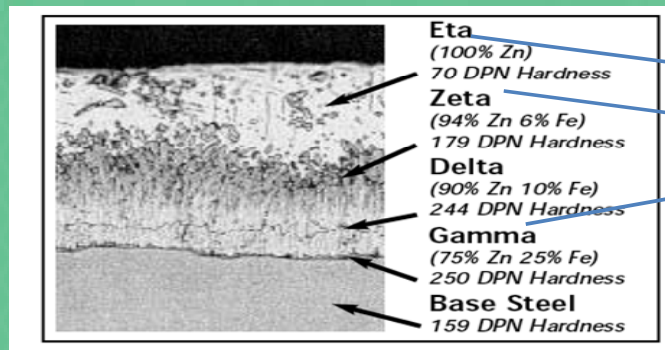
The **ArmorGalv®** coating follows exactly the contours of the article – with uniform thickness over the entire surface of the part, including complex-shaped articles.

ITW Automotive, Carbon Steel Armor Galv @ 10X



Parts coated with **TDG**

TDG vs. Hot Dip Galvanize

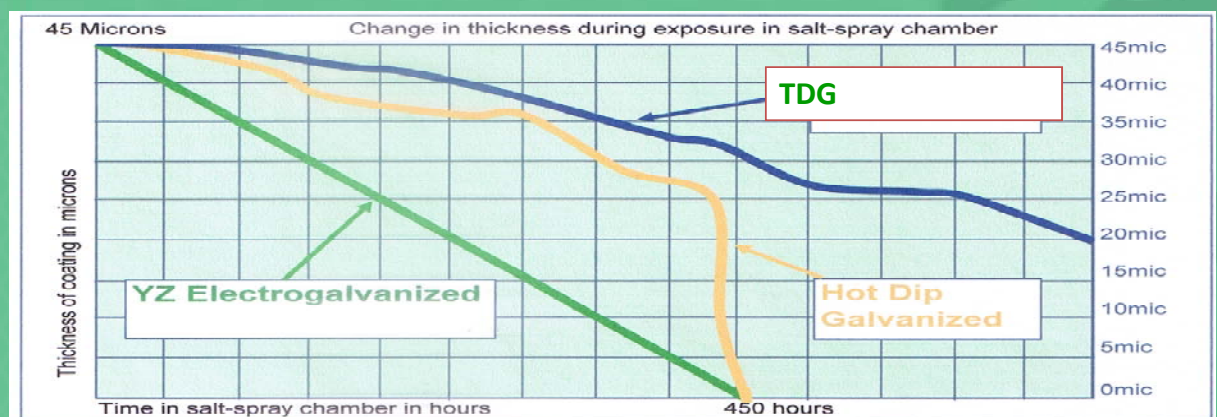


Hardness 45 HRC

The Eta (pure zinc) layer in HDG is thick, but non-existent in the **TDG** coating. This layer has much less corrosion resistance than do the zinc/iron phases of the **TDG** coating.

The high corrosion resistant Zeta, Delta and Gamma layers are much thinner than in the **TDG** coating.

Comparison of Coating Weight Loss in Salt Spray



Each Succeeding Phase Layer of **TDG** is **More Corrosion Resistant** Than The Previous Layer

The Corrosion Product of **TDG** Forms a "Patina" – Which Has Corrosion Protection Properties in Industrial Environments.

The service life of the **TDG** zinc alloy coating is, therefore, significantly higher than that of the Electro-Plating or than that of Hot Dip Galvanizing when exposed to industrial and marine environments.



HDG 2 Mils- After
3 Years in the
Aggressive Dead
Sea Atmosphere.
Badly Corroded

**North Sea:
35 G/L Salinity**

**Dead Sea:
300 G/L Salinity**



TDG - 1 Mil After
3 Years in the
Aggressive Dead
Sea Atmosphere.

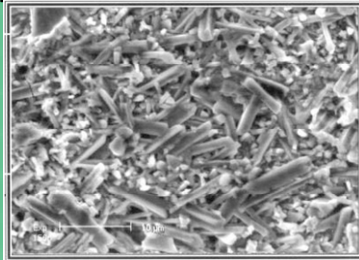
No Corrosion

The **TDG** coating is harder than that of other zinc coatings and offers excellent resistance to abrasive wear. **TDG** provides an excellent substrate for additional surface treatment (painting, electro-coat, powder coat, rubberizing, Teflon etc.) -



Thermal Diffusion + Paint

TDG surface is not smooth like that of electroplated zinc (or Hot Dip Galvanized), but is rather “geographic”, as illustrated in the photo below.



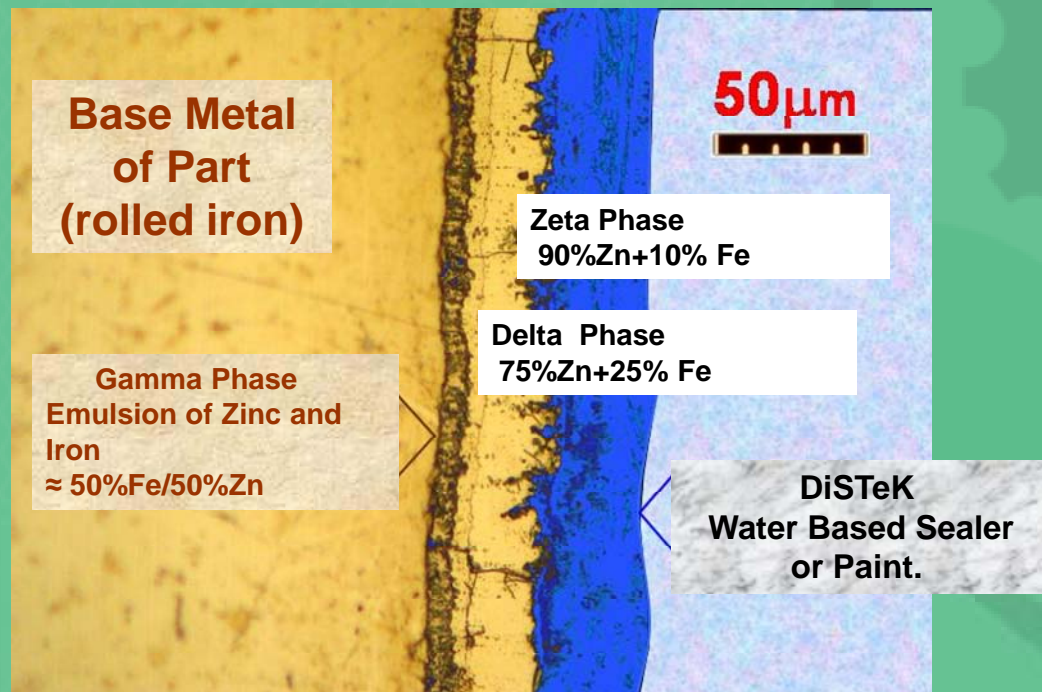
TDG surface



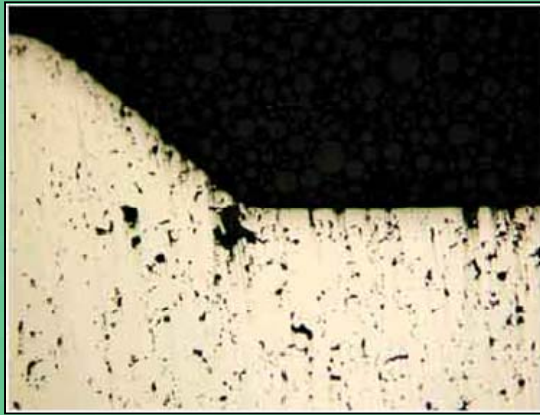
Electro-plated Zinc surface

The **TDG** surface results in superior adhesion of any top coat. The smooth surface of electro-plating requires various preparations such as chromating and primers to provide basic adhesion of paint.

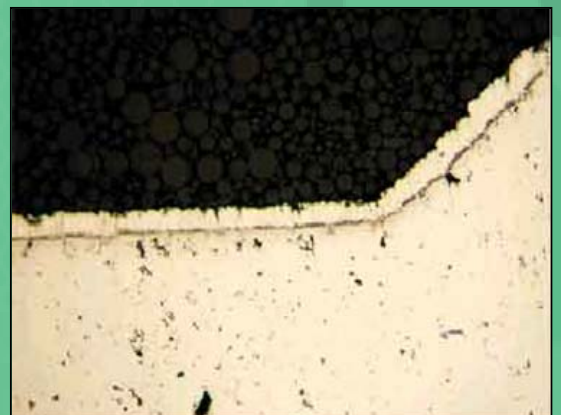
Thermal Diffusion + Paint



TDG is particularly effective for coating parts made of **powdered metal**, castings, porous parts, and assemblies.



Before **TDG**



After 50 microns of **TDG**

Where Does **TDG** Fit in?

TDG is cost competitive with HDG and Zinc Alloy Electro-Plating for high corrosion resistance.

TDG has the ability to coat nuts, blind holes and deep recesses inside and out uniformly.

TDG allows for high thickness (1-3 mils) construction application without re-cutting and exposing threads.

TDG is the anti corrosion system of choice for rebuilding the infrastructure .

If it needs to last and hold things together – it needs **TDG .**

Where can **TDG** Fit in the U.S Military?

TDG offers a combination of properties that make it suitable for numerous applications in all branches of the military, such as:

- Provide significant reduction in **life cycle costs** of equipment and structures.
- **Replacement for Cadmium** and other toxic coatings, wherever they are used for corrosion protection and to prevent galling.
- Protection for fasteners and hardware on land vehicles like the M1A, STRYKER, HUMVEE, ARTILLERY , amphibious vehicles and others.
- Communication towers.

- Corrosion protection and wear resistance for parts exposed to abrasive elements, like folding stock of rifles and machine guns
- We are currently coating a radio grounding stake, part #659376 (made by R.A Miller).



- **TDG** Acts as a bearing surface for parts like pivoting pins, possibly link pins on tank treads...
- Provides long shelf life and abuse resistance to various forms of ordnance. For instance we could do green colored coating and eliminate the need to paint.
- Replacement of brass shell casings with high strength, light weight , corrosion resistant, anti galling low cost steel.

- Due to the outstanding corrosion resistance in marine environments and paint adhesion properties, the U.S Army , Marine Corps, Navy and Coast Guard can greatly benefit from this technology.
- we are currently coating parts made by Spencer Industries for the Navy: forged chain hook (Navy) part number SPN 000573-1.



- We are now working on coating the whole chain sling assembly, providing a combination of corrosion and abrasion protection.

- **TDG** can be a duplex system, involving special paints or barrier type coating applied over **TDG**. This type of coating is used extensively in the off shore oil fields for extreme conditions and it may have some interesting Military applications as well.
- Protect structural elements, particularly for marine environments, providing modular, long lasting structures.
- A system can be developed for building modular steel structures, protected by **TDG** and then bolted together. Such structures could offer a cost effective building system which has a very long life cycle, low maintenance cost and great shelf life for structures that are stored and then shipped overseas to be assembled.
- Illustrated below is a coating system for structural elements.

Coating plant for 40' long structural elements



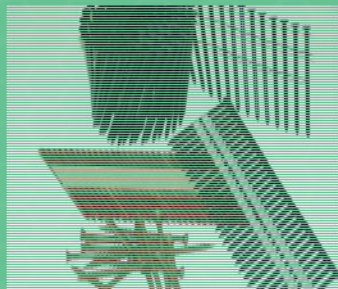
TDG coated steel structure



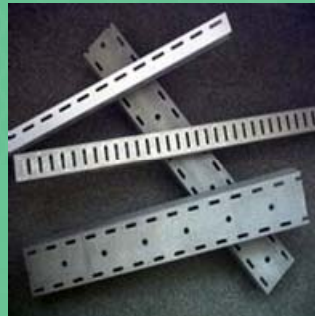
TDG Coated & painted Steel Structure



Cylindrical, Threaded Parts and Different Shafts



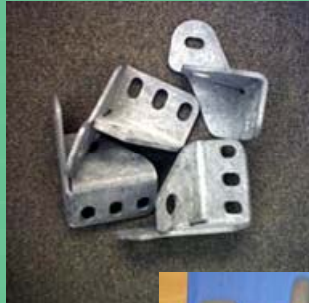
Flat and Formed Parts



Nuts, Cast and Thick-Walled Parts



Fabricated, Movable Hinged Items and Welded Assemblies



Tubes, Pipes, and Fittings – Coated *Uniformly* Inside and Out



TDG is Environmentally Friendly

- The EPA, in a 2006 extensive study of the Thermal Diffusion technology, has stated that the process “does approach Zero discharge”.
- The **ArmorGalv®** Thermal diffusion process is the winner of the 2006 Most Valuable Pollution Prevention Technology Award (MVP2).



TDG Testing/Approvals

- **Standards:**
 - ASTM A-153 Class D (Mass per area of 1 oz or 2 oz/sq. ft.)
 - ASTM A641-98 Class 1 and 3 (zinc coating thickness requirement, i.e. 12 to 15 microns, and 90 microns)
 - European Community Standard-BS EN 13811:2003
 - Russian standard-GOST P 51163-98
 - Israeli standard-4271
 - **ASTM STANDARD #A1059/1059M**
- **Tests**
 - **Dade county PA114 Appendix E Sec. 2 (ASTM G85/A5)**
 - DIN 50021 and DIN 50018
 - South Africa EDS evaluation
 - Michigan State University- ACQ Test
 - US Environmental Protection Agency (US EPA), USA-B117
 - Siemens Laboratories, Germany
 - Dresden Corrosion Institute, Germany
 - Brussels Metallurgical Laboratory, Belgium
 - Russian Machine Building Laboratory
 - Israel Standard Institute
 - Swedish National Institute of Testing
 - National Product Development Centre SA

ASTM STANDARD

Thermal Diffusion

A new ASTM standard

#A1059/1059M

Has just been published

IN CONCLUSION:

- **TDG** allows for the deposition of a highly corrosion and abrasion resistant, **non toxic non polluting** zinc/iron alloy on practically any part to thicknesses ranging from 10 to 300 microns cleanly, efficiently and uniformly.
- **TDG** vastly increases the service life of steel parts, in a safe, environmentally friendly, process without regards to geometry or complexity.

Thank you

- Moshe Moked, P. Eng.
- President of Distek N.A LLC
- 617-566-0058
- moshe@distekna.com